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ABSTRACT

This report reviews traditional research on studying and supplements it with theory and research from other areas of education and psychology to obtain a clearer picture of the way people study. The state variable of the student's knowledge of the criterion task and the processing variables of encoding and of focusing attention are explored. Some of the studying techniques reviewed include underlining, note taking, rereading, summarizing, student questioning, and representing the text diagrammatically. The conclusions reported suggest that some techniques have more potential than others for promoting the deeper processing suited to criterion tasks requiring greater comprehension and/or recall. It is noted also that the techniques most likely to yield the highest learning benefits also have the greatest cost in student time and energy. (MKM)

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CENTER FOR THE STUDY OF READING

Technical Report No. 155

STUDYING

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Studying

Studying is a special form of reading. The way that studying differs from "ordinary reading" is that studying is associated with the requirement to perform identifiable congitive and/or procedural tasks. This performance-related aspect of studying was acknowledged several decades ago by Butterweck (1926), who suggested that the one definition of studying applicable to every possible school situation is "a pupil activity of the type required to satisfy the philosophy of education held by the teacher" (p. 2). "Satisfying the philosophy of education held by the teacher" translates as meeting the criteria on tasks such as taking a test, writing a paper, giving a speech, and conducting an experiment.

Although studying has been the object of investigation since early in this century, the traditional studying research has little to offer theorists or practitioners. However, when the traditional research on studying is supplemented with theory and research from other areas of education and psychology, a clearer picture of studying begins to emerge. The purpose of this paper is to portray that picture.

We use an organizational scheme that has two major components: state variables and processing variables. The state variables are those related to the status of the student and the to-be-studied material at the time of studying. Important student variables include knowledge of the criterion task, knowledge of the content in the to-be-studied material, and motivation. Important text variables include content covered, organization or structure,

and other features which affect the "readability" of the prose. The processing variables are those involved in getting the information from the written page into the student's head. Processing variables include the initial focusing of attention, the subsequent encoding of the information attended to, and the retrieval of the information as required by the criterion task. As we see it, the outcomes of studying are a function of the interaction of state and processing variables. In this paper, we discuss some of these components and review related research.

State Variables

Although state variables include several student- and text-associated variables, we will discuss only student knowledge of the criterion task. We focus on this variable because it is uniquely associated with studying as opposed to other types of reading.

Knowledge of the Criterion Task

According to our definition, studying involves reading in preparation for performing a criterion task. The nature of the task and associated criteria are known to students in varying degrees. Students' cognizance of the task may range from having complete knowledge (e.g., a copy of the test to be administered) to almost no knowledge (e.g., information that the test will be paper and pencil and that it will cover World War I). The degree of knowledge that a student has about the criterion event is one important state variable influencing studying outcomes.

The underlying assumption about the relationship between knowledge of the criterion task and studying outcomes is simple: when the criterion

task is made explicit to the students before they read the text, students will learn more from studying than when the criterion task remains vague. This notion is supported by several lines of related research in which degree of knowledge of the criterion task is manipulated.

The first line of research addresses the situation in which students have complete knowledge of the criterion test. This research involves the use of questions inserted in text which students are required to answer as they read. In a comprehensive review of the adjunct question literature to date, R. Anderson and Biddle (1975) concluded that, in general, the availability of these questions facilitates learning from text. Of particular relevance is the situation in which the criterion test items exactly match the inserted questions. Data from 14 studies show that performance on such repeated items is 10.8% higher than performance on items that had not been available during studying. Clearly, this result from adjunct question studies shows that when the criterion task associated with studying is made explicit to students early in the studying session, it can have a reliable, beneficial effect on criterion task performance.

Other research investigates the middle ranges of knowledge about the criterion task, in which students have some information but not the actual test items. This area of investigation includes research on the use of behavioral objectives and research on typographical cueing on text. The behavorial objectives research investigates the effect on learning of giving students a set of behavioral objectives, which typically include information about the topic to be learned and how the student can demonstrate that the information has been mastered. The research on typographical

cueing investigates the effect on learning of underlining and other techniques of physically highlighting sections of prose. Presumably these techniques cue information that is likely to be tested. The effects of objectives and typographical cueing on criterion test performance are similar. Combining the conclusions of T. Anderson (in press) with respect to objectives, and T. Anderson (in press) and Glynn (1978) with respect to typographical cueing, both techniques appear to facilitate learning, at least of those text ideas specifically cued by the objectives or typographical devices. Furthermore, with regard to objectives, the more specific the objective (that is, the closer in form to the test item), the greater the effectiveness. In sum, providing less than complete information about the criterion task in the form of objectives or typographical cueing is effective but less potent than providing complete information in the form of adjunct questions. This finding is consistent with the hypothesis that performance on the criterion task is a function of knowledge of the task.

A final line of research to be discussed here pertains to the situation in which students have little knowledge of the criterion task. In this research, students are told and/or shown the type of items that will be used on the criterion test. They then study the content material with the expectation of being tested in the prescribed test mode. In most designs they are tested in the prescribed, as well as one or more other, modes.

This line of research blossomed in the 1930's in response to the then "new" mode of testing--multiple choice. Seemingly, researchers at the time were attempting to show that the new objective tests were detrimental because (a) students would not study as thoroughly for the multiple choice exams

as they would for the "tried and true" essay or completion exams, and (b) students would study for the multiple choice exams by learning details of the text at the expense of the main ideas. It is important to note that at this time multiple choice tests were primarily used to assess knowledge of details. Therefore, when students in the early experiments were told that they would have an objective test, it was easy for them to interpret this to mean a test over details in the passage.

Two studies by G. Meyer (1934, 1935, 1936) confirmed the hypothesis that when students anticipated essay and completion exams they performed generally better on all types of tests than when anticipating true-false and multiple-choice types. Because he conducted the experiments in a laboratory where he could observe studying behavior, Meyer was able to determine that students who were studying for an essay exam tended to write more summary statements, while students studying for an objective exam did more "random" note-taking and underlining.

Other early studies by Class (1934) with college students and by Vallance (1947) with high school students failed to find performance differences in students expecting different kinds of tests. It should be noted, however, that Class used only a true-false criterion test. Judging from Meyer's data, true-false tests seem to be the least sensitive measure of the effects of test expectation. Therefore, Class's choice of criterion test may have biased the results.

In more recent years, Hakstian (1971), Kulhavy, Dyer, and Silver (1975), Lucas (Note 1), and Rickards and Friedman (1978) also report no effect of anticipated test type on overall criterion test scores. However, the latter

two researchers approached the question in a somewhat different way by separating the criterion test items into those measuring idea units of high structural importance and those measuring idea units of low structural importance. A reanalysis of the data organized in this way revealed that students instructed to study for an essay exam learned more ideas of high importance than did the group instructed to study for multiple choice tests. In addition, students studying for a multiple choice test learned more ideas of low importance than high importance.

In conclusion, the results from several lines of research generally support the hypothesis that the more specific the knowledge about the criterion event, the greater the effectiveness of studying. In those conditions where the criterion task is known exactly (e.g., inserted questions identical to criterion test questions), performance is much higher than that found in a control condition. The effectiveness of studying decreases as knowledge of the criterion task decreases. Finally, when the nature of the criterion task is only vaguely known (e.g., only the type of test is known), facilitative effects are seldom demonstrated.

However, knowledge of the criterion task will not affect performance unless students change their studying strategy accordingly. For several <u>good</u> reasons, students might opt <u>not</u> to change their normal studying strategy. First, the text to be learned may be so short that the students feel they can learn it all anyway. Second, the information to be learned may be so extensive (e.g., long lists of objectives or dense underlining) that students believe they cannot possibly master it no matter what strategy they use. Third, the information about the criterion task may be at odds

with the content and/or expectations about what a reasonable task should be; because the information has low credibility, students may reject it. In sum, for information about the criterion task to have an effect on students, it must lead the students to believe that if they modify their studying behavior in accordance with the expected outcomes of the studying session, they will do better on the criterion task. The actual studying behavior--what students do in response to their knowledge or beliefs about the task demands--is the topic of the next section.

Processing Variables

Knowledge of the criterion task may be a necessary condition for optimal studying, but is is obviously not a sufficient condition. Knowledge of the criterion task must be accompanied by processing of the relevant information. That is, students must get the information from the text into their heads. In realistic studying situations, this processing demand is very heavy. For example, it is not unusual for a single page of expository text to have at least 50 idea units which could be interrelated in a vast number of ways. In a chapter of text, the number of ideas and relationships is mind-boggling indeed. Consequently, it is folly to think that a student could (or should) learn and remember all, or even most, of the content in a textbook chapter. Therefore, the prime tasks of the student are to (a) focus attention, and (b) engage in encoding activities in a way that will increase the probability of understanding and retrieving the "high pay-off" ideas and relationships. In other words, the students must select the segments of text that contain the important ideas and ensure that they are well understood and likely to be remembered.

Focusing Attention

Historically, there has been little research on attention focusing. While earlier researchers included attention focusing as part of their operational theories (i.e., by collecting retrospective questionnaire data from students about how they processed the material), it was not until recently that more novel techniques have been used to monitor and, at times, control attention focusing.

A study by Reynolds (1979) used some of these attention monitoring and controlling techniques. In the first experiment, college students read a 27-page text from Rachel Carson's The Sea Around Us, a light, technical, descriptive exposition. Students read the text from a computer screen where it was presented in four-line clusters of about 33 words each. The text was altered so that each cluster made reference to either a technical term, a proper name, or other information which was considered filler material. As with the adjunct question research, some students received a question inserted at equal intervals in the text which they were required to answer before continuing. Some students answered questions about proper names and others about technical terms. Still other students received no questions. On a later criterion test all students received items about technical terms and proper names. (See Reynolds, Standiford, & Anderson, 1979 for details on this procedure.)

While the students read the text, the computer kept track of the inspection time for each text cluster. In addition, reaction time to a secondary task was also recorded by the computer. The secondary task required the

student to press the space bar on the terminal keyset when a tone sounded. The reaction time to this secondary task was used as an index of cognitive effort being expended at the time of the tone.

Results from this study reveal the same pattern as those reported in earlier work (Reynolds, Standiford, & Anderson, 1979) on the effects of adjunct questions. That is, students scored better on criterion test items of the same type as the inserted questions. The important new finding was that the inspection and reaction times were greater when students were studying "relevant" text segments than when studying the filler or irrelevant segments. In addition, positive correlations were found between inspection time and test performance and between cognitive effort (reaction time) and test performance.

These results suggest the following scenario. Students process the entire text in a general "reading to comprehend" mode. When students determine that a segment of text is relevant to the criterion task, two processing changes occur: (a) the amount of inspection time on that text segment increases compared to that on task irrelevant text segments, and (b) the amount of cognitive effort or concentration increases. These increases in inspection time and cognitive effort are reflected in improved performance on the corresponding test items. Note that processing does not appear to be an "all or none" phenomenon. The fact that students do remember <u>some</u> information not cued by questions indicates that they are at least processing at a minimal level the task-irrelevant parts of the text. The focusing seems to involve a burst of processing energy or a quantum leap in cognitive effort beyond the baseline processing.

Results from other studies manipulating reading rate or studying time seem to support, or at least not refute, this model of attention focusing (Arkes, Schumacher, & Gardner, 1976; Geiselman, 1977). In two experiments McConkie, Rayner, and Wilson (1973) induced college students to read six 500-word passages at a fast pace or at a moderate pace by manipulating the payoff conditions for learning the content. In addition, students received different types of inserted questions (related to numbers, facts, recognition, higher order, etc.) after each passage. On the criterion test, students received all types of questions. Results indicated that the slower paced students scored higher than the faster paced, and that increasing speed had little effect on the retention of information for which a person is specifically reading, but reduces the learning of task-irrelevant information. Thus, if time constraints so force them, students may reduce or abandon the minimal baseline processing in favor of more intensive processing of information relevant to the criterion task.

In another study, Alessi, Anderson, and Goetz (1979) manipulated rate in yet another way. The underlying assumption of the study was that some types of expository text have strict prerequisite dependency among ideas; that is, mastery of Concept A is necessary before Concept B can be understood. The text was administered to subjects in a way similar to Reynolds' experiment (1979). The experimental manipulation occurred when students were required to answer an inserted question requiring knowledge about Concept A just prior to reading about Concept B. Half of the students who did not answer the question correctly were allowed to proceed directly to Concept B. The other half of the students who did not answer the

question correctly were branched back in the text to that segment which dealt specifically with Concept A before they were allowed to read Concept B. Results showed that students who received lookbacks showed better comprehension of the later information (about Concept B) than when lookbacks were not provided. Thus, these results support the important relationship between attention focusing and performance on related criterion test items. Furthermore, the study shows that if students fail to process important text adequately when first encountering it, additional focusing can have beneficial effects. Of course, in this study the computer was deciding for the student where and when the focusing should occur. Presumably, successful students eventually learn this skill themselves.

In sum, several studies have demonstrated the importance of focusing attention on task-relevant information during studying. The next section addresses the question of the encoding processes that accompany the focused attention.

Encoding

What cognitive processes actually occur when students focus attention and concentrate harder is only conjecture at this point. However, two theoretical frameworks suggest in a very general way some processing variables relevant to studying. The first theoretical framework is the "principle of encoding specificity" (Tulving & Thomson, 1973).

According to the principle of encoding specificity, the way in which information is encoded determines how it is stored, which in turn determines which retrieval cues will effectively access it. This principle calls attention to the important interaction between initial encoding and subsequent

retrieval operations: The optimal form of processing is ultimately dependent on the nature of the retrieval task. The implication of the encoding specificity notion for studying is that studying will be facilitated to the extent that students know the performance requirements of the criterion task and encode the information in an optimal form to meet those requirements. If the student knows the exact questions to be asked, he should study the responses. If the student does not know the exact task but knows the general type of task, he should focus his studying on the class of appropriate responses to tasks of that type. For example, if the criterion task requires the application of principles to new examples, the student should practice applying the principles during the studying session.

Processing the information in a form as close as possible to the requirements of the criterion task is only part of the problem. The student must also be concerned with the qualitative nature of the processing; he must ensure that the requisite information is processed in such a way that it is stored and available when needed to perform the criterion task. A theoretical framework pertaining to the qualitative aspects of the processing effort is the principle of "levels of processing" (R. Anderson, 1970, 1972; Craik & Lockhart, 1972).

According to this principle, stimuli are analyzed in a hierarchy of processing stages, from an analysis of physical or sensory features to extraction of meaning. The durability of memory traces is a function of "depth of processing," where greater depth implies a greater degree of semantic analysis. In other words, what is stored in memory is determined by the kinds of operations performed on the input. The implication of the "levels of processing" notion for studying is that performance on criterion

tasks requiring comprehension and recall will be facilitated to the extent that students attend to, interact with, and elaborate on the underlying "meaning" of the text.

Together, then, the principles of encoding specificity and levels of processing suggest that studying will be effective if students process the "right information" in the "right way," where "right information" is defined with respect to the criterion task and "right way" connotes a relatively deep or meaningful level of involvement with the text.

Students can and do engage in a variety of covert and overt activities to help them process the right information in the right way. Most of the common studying techniques, such as underlining, note-taking, summarizing, and outlining are commonly used because teachers of studying and students alike intuitively believe that these methods will help the student learn and remember the required information. Unfortunately, empirical research fails to confirm the purported benefits of the popular strategies. So far, the effort to find the one superior method has not been successful; the few studies that have been done present a confusing array of inconsistent results. In the next section we propose that the confusion stems from a failure to consider the interaction of the state and processing variables discussed in this paper. We will develop the case that, for the most part, research on common studying techniques has so far ignored the influence of the student's knowledge or beliefs about the criterion task and the match (or mismatch) between the encoding processes during the studying session and the retrieval processes required for performance of the criterion task. Usually the reader of the research report knows neither what subset of

presented information the subject selected for processing nor the depth of the processing effort. Information about the studying condition to which a subject was assigned does not reveal the precise nature of the processing activities used by the subjects. For example, a subject who is "taking notes" could be merely copying the author's words, which entails a very superficial level of processing, or he could be engaging in deep processing as reflected in notes that reorganize or elaborate the input.

In addition, readers are often uninformed about the criterion task. Even if the researcher reported the general type of test (e.g., constructed response or multiple choice), this information is insufficient to convey the depth of processing required to perform the task. For example, multiple-choice questions could test knowledge ranging from detail or recognition to application of principles (R. Anderson, 1972).

Research on Common Studying Techniques

Underlining

Perhaps because it is quick and easy, underlining is probably the most popular aid used in studying text. However, by far the majority of research done on student-generated underlining shows it to be no more effective than other studying techniques (Arnold, 1942; Hoon, 1974; Idstein & Jenkins, 1972; Kulhavy, Dyer, & Silver, 1975; Stordahl & Christensen, 1956; Todd & Kessler, 1971; Willmore, 1966). It is difficult to comment on these results because insufficient information is provided about the encoding and retrieval processing variables--what the subjects underlined and the requirements of the criterion test.

Three studies showed positive results for underlining (or its equivalent, highlighting). Rickards and August (1975), Schnell and Rocchio (1975), and Fowler and Barker (1974) all used designs comparing groups who produced their own text cues, groups who read cued materials, and groups who used uncued text. The results of the three studies are similar. In the Rickards and August study, college students who had actively underlined the passage recalled significantly more idea units and spent considerably more time on the task than subjects in the other treatment groups. The increased studying time and greater recall may indicate that students who underline may be processing the text more thoroughly than they otherwise would.

In the Schnell and Rocchio study, high school students who received an underlined text or who underlined their own text recalled a greater number of idea units on immediate and delayed free recall tests than students who read an uncued text. In addition, students who did their own underlining scored significantly higher than the other two groups on the immediate recall test.

Fowler and Barker found no overall difference between treatments in performance by college students on a delayed multiple-choice test. However, subjects who highlighted the text outperformed subjects who received a highlighted text on items corresponding to highlighted materials, but not on items corresponding to unhighlighted material. Also, for active highlighters, the probability of getting an item correct given that the corresponding information had been highlighted was significantly greater than

the probability of getting an item correct if the corresponding information had not been highlighted.

The results of these studies indicate that the major benefit of underlining does not come from the mere cueing of information, for text with supplied underlining cues information but does not necessarily enhance recall. Rather, the primary facilitative effect of underlining occurs when the student generates the underlining, presumably because of the amount of processing required to make the decision about what to underline.

Note-Taking

Note-taking vies with underlining for popularity as a studying aid. Theoretically, note-taking has great potential as a studying aid, for it allows the student to record a reworked (perhaps more deeply processed) version of the text in a form appropriate for the criterion task. However, the few studies that have been done on note-taking from prose have mixed results, with most studies showing that note-taking is no more effective than other studying techniques. In this section, the results of empirical studies of note-taking will be discussed with respect to state and processing variables. Studies showing positive effects for note-taking will be discussed first.

In two experiments, Shimmerlik and Nolan (1976) had high school students read a 1200-word passage organized in one of two ways. Students were instructed to take notes that either maintained the presented organization or imposed an alternate organization. On immediate and delayed free recall measures, students who reorganized the passage in their notes recalled significantly more idea units than students who maintained tne original organization. A possible explanation for this finding is that reorganizing

the passage forces deep processing of the text; the subject has to understand the original organization as well as think through how the content and relationships must be restructured to form the new organization. Repeated semantic operations on the content and relationships led to more durable memory traces. This type of encoding was well suited to a free recall criterion test, in which the subject's score reflects ability to reproduce content and relationships in the absence of retrieval cues. On the other hand, subjects who took notes that maintained the original organization did not necessarily have to process the material at a deep level; they therefore had less information available and/or accessible.

Bretzing and Kulhavy (1979) had high school subjects read a 2000-word passage in one of four conditions designed to promote different levels of processing: (a) write summaries of each page, (b) take paraphrase notes of the main idea, (c) take verbatim notes, and (d) record words beginning with a capital letter. A control group simply read the passage. On a test of constructed response items requiring integration of information, summary writers and paraphrase notetakers performed equally well and significantly higher than verbatim notetakers, who performed the same as the reading-only control group. Subjects who were assigned the letter search task fared worst of all. The authors explained the results in terms of levels of processing--writing summaries and taking paraphrase notes require greater cognitive effort than do the other treatments. A supplementary explanation might be that the subjects who summarized and took paraphrase notes were encoding the information in a form compatible with the requirements of the criterion test, while subjects in the other conditions were not. Indeed, the studying activity

least similar to the criterion task (searching for capitals) produced the worst performance.

In an experiment by Kulhavy, Dyer, and Silver (1975), high school students either read, underlined a limited amount, or took limited notes on a narrative. In addition, they were either given no instructions about the criterion test or told to expect either a multiple-choice or constructed-response test. On the criterion measure consisting of both multiple-choice and constructed-response items, notetakers significantly outperformed underliners and read-only subjects, who did not differ from each other. These results are difficult to interpret because no information is provided about the type of notes taken, which might indicate the nature of encoding. However, as the authors point out, since the notetakers significantly outperformed the underliners, they seemed to be doing "something more" than merely identifying information. The limitation on the amount of notes taken per page may have induced subjects to record summary statements, which would presumably require a deeper level of processing.

One of the results of an early study by Mathews (1938) provides additional support for the effectiveness of note-taking. Seven hundred thirty-five high school students studied a 2000-word passage by either reading and rereading, reading and taking marginal notes, or reading and taking notes in outline form. Overall, the groups did not differ significantly in performance on a test consisting of multiple-choice items and items requiring outlining or organizing of information. However, subjects who read and took

notes in outline form tended to score highest on the outlining half of the test. In terms of the encoding specificity hypothesis, this situation reflects an optimal match of encoding and retrieval processes.

In contrast to the few studies showing positive results for note-taking, most studies do not show an advantage for note-taking compared to other studying strategies. These results are difficult to interpret because of a lack of information about state variables (what students knew or expected the task demands to be) and processing variables (encoding as reflected in the focus and nature of the notes taken and the retrieval demanded by the nature of the criterion task). In most of these studies, however, subjects are probably either not processing the right information with respect to the criterion task or are not encoding the information as deeply as they might be in another condition. This conclusion is based on the following line of reasoning.

The first possibility is that subjects may not be processing the right information. In most experiments, subjects have a limited studying time, which is usually the same for all treatments. Obviously, taking notes requires more time than simply reading the text. The time that notetakers use to record some information is time subtracted from processing other information. In the absence of knowledge of the criterion task, subjects take notes over what they think will be tested. Probably subjects select the "main idea" or "most important" information as the focus of their note taking efforts; they may not have time to process less important information. Research has shown, however, that people tend to remember the "most important" information anyway (e.g. Johnson, 1970; Meyer & McConkie, 1973; Meyer, 1975). Therefore, note-takers may be learning "main ideas" very well, but at the expense of learning

other information. On the other hand, subjects who use less time-consuming studying techniques (e.g., read-reread and underline) are able to distribute their attention and effort more evenly over the passage. Therefore, a read-reread group, for example, might have an advantage over a note-taking group when the criterion task taps information of lesser importance, or when the criterion task is free recall (in which case the score reflects total number of idea units recalled without respect to importance). The second possibility for the apparent ineffectiveness of note-taking is that subjects may not be taking notes in a way that entails deep processing. For example, subjects may choose to record information verbatim from the text rather than recording a reworked, paraphrased representation of text meaning. Either or both of those analyses may help explain the results of the following studies.

Arnold (1942) had college students study history in one of four conditions: reading with underscoring and marginal notation, reading and outlining important ideas, reading and summarizing, or repetitive reading. The criterion test consisted of both factual questions and higher-level comprehension questions. A reanalysis of the data by T. Anderson (in press) revealed that on both immediate and delayed tests, repetitive reading was the most effective strategy. In a study by Todd and Kessler (1971), college students studied a short story using strategies of underlining, note-taking, or reading only. Total number of idea units recalled on a free recall test did not differ for the three groups. Howe and Singer (1975) had college students study a 286-word passage in the following conditions: take verbatim notes (copy), summarize each paragraph, or read-reread. Results on both immediate and delayed

free recall measures showed that the read-reread group outperformed the summarizing group, who in turn excelled the verbatim notetakers.

In two experiments by Poppleton and Austwick (1964), post-graduate students and 12-to-13-year-olds either worked through a programmed text and filled in the blanks or read and took notes on the same material presented in the form of a textbook. On an immediate-criterion test consisting of constructed response, multiple-choice, and application items, the adults performed equally well in either condition, but the children scored significantly higher in the programmed-text than in the note-taking condition. Compared to taking notes, working through the programmed text may have elicited deeper processing as subjects actively searched their semantic store or engaged in lookback behavior in the text itself. It may also be that subjects in the programmed-text condition were forced to make the kinds of responses required by the criterion test, while those in the note-taking condition were spending the available studying time recording information unrelated to the criterion test.

In some studies, the ineffectiveness of note-taking compared to other studying strategies may be because the potentially deeper processing associated with note-taking is not the right way to process the particular passage with respect to the criterion task. One example of this situation is a study by Schultz and DiVesta (1972). The stimulus passage used in this study consisted of statements about six attributes of six imaginary nations. The passages were organized in one of three ways: (a) Name Organization--the six attributes of a single nation were presented together, (b) Attribute Organization--for a given attribute, the different values associated with each nation were presented

together, or (c) Random Organization. Thus, the stimulus passages were lists of facts. List-learning can proceed smoothly without requiring deep processing. Therefore, it is not surprising that the high school subjects who took notes had no advantage over subjects who (presumably) spent the studying time in reading and mental rehearsal. In fact, under such circumstances, note-taking could be detrimental--if notetakers do engage in deeper processing, they may actually store a less accurate representation of the text meaning--a representation colored by their prior knowledge, perspective, and interests. This outcome was realized in the Schultz and DiVesta study, for notetakers introduced a significantly greater number of errors and had a greater tendency to recall information in a different organization than that of the stimulus passage.

Another example in which the type of processing associated with note-taking may have biased the results is the previously cited Todd and Kessler (1971) experiment. The stimulus passage used in this study was "The War of the Ghosts" (the story used in Bartlett's, 1932, well-known prose-learning research). "The War of the Ghosts" is a very unusual passage--it is a story from another culture with a structure and content unfamiliar to most American college students. Distortions and intrusions in the recall of this passage are the rule rather than the exception. With the potential of deeper processing, a note-taking condition might accentuate the tendency to alter the structure and content of this passage, thus depressing the accuracy of free recall. In sum, the Schultz and DiVesta (1972) and Todd and Kessler (1971) experiments suggest that note-taking may not be an asset to processing if

the material to be learned is a list of facts or has some very unusual characteristics.

In conclusion, our analysis of the research on note-taking from prose suggests that note-taking can be an effective strategy if it entails attention-focusing and processing in a way compatible with the demands of the criterion task. In studies where note-taking has not been found too effective, it may be because students were either focusing attention on and processing information unrelated to the demands of the criterion task or failing to take notes in a manner that elicited sufficiently deep or thorough processing.

Summarizing

Finding research to support summarizing as a studying activity is difficult. One study with results in support of summarizing was the Bretzing and Kulhavy (1979) study discussed in the previous section, in which summarizers significantly outperformed a reading-only control group. To our knowledge, no other research has found summarizing to be more effective than repetitive reading. In fact, studies by Germane (1921a, 1921b), Arnold (1942), and Howe and Singer (1975) found summarizing to be inferior to a read-reread strategy. In a study by Stordahl and Christensen (1956), the effect of summarizing was no different than the effect of using other techniques, including repetitive reading.

The explanation for the apparent lack of effectiveness of summarizing parallels that used with regard to note-taking: in a summarizing condition, subjects are probably not focusing attention on or processing the right information in the right way with respect to the criterion task. In producing their summaries, subjects are presumably using the available studying time

locating, organizing, and recording the main ideas, which they would have recalled relatively well anyway. Summarizers probably do not have time to process information of low structural importance. In contrast, the reading-only subjects have time to process information at all importance levels. The criterion tests for all studies except the Howe and Singer (1975) experiment were objectve tests that probably included items tapping knowledge of less important passage information. Therefore, it is not surprising that the repetitive readers scored higher on the criterion measures. On the free-recall tests of the Howe and Singer study, summary writers recalled significantly more items than subjects who merely copied the text, which probably reflects the greater processing that may be entailed in generating a summary.

According to our analysis, summary writing is likely to be most effective as a studying strategy if the student is actually reordering and reworking the text in order to construct an abstract and if the criterion task requires the retrieval of deeply processed main ideas.

Student Questioning

The questioning technique requires that students generate questions about the prose they are studying. This technique is similar to note-taking in that the student makes a written record of selected information from the text. The questioning technique differs from note-taking in that the format of the recorded idea is that of a question. Theoretically, the processing effort required to generate questions should result in studying gains.

Several studies have compared the effects of questioning behaviors when the student generates the question versus when questions are given to

the student. Significant differences favoring student construction of questions were found in three investigations. In a study by Duell (1978), college students who constructed multiple-choice questions from instructional objectives outperformed students who simply studied the passage with the list of objectives on a criterion test consisting of lower-level recognition items and higher-level application items. In a study by Frase and Schwartz (1975), both high school and college students who wrote questions scored significantly higher than reading-only controls. Furthermore, students scored significantly higher on "targeted" test items (test items for which they had written similar studying items) than on nontargeted items (test items with no corresponding student-generated item). Finally, Schmelzer (1975) demonstrated positive effects on a multiple-choice criterion test for a strategy of generating questions after reading.

Positive results for student generation of questions were also obtained in a study by André and Anderson (1979). In this study, one group of high school students were trained to write questions about main ideas. On tests over two passages, a questioning with training group and a group who wrote questions without training obtained higher scores than a read-reread control group. The two question-writing groups did not differ from each other, but low and middle verbal ability students benefited from training in question writing more than did high verbal ability subjects.

In other studies, the student-generated questions treatment had no effect. Specifically, Pederson (1976) used Schmelzer's (1975) materials and failed to replicate the earlier results. In addition, Bernstein (1973),

Morse (1975), and Owens (1977) were unable to find an effect for student questioning.

It seems plausible that when student questioning is effective, it is so because students are forced to encode the information more than they might if they simply read it. Writing questions probably requires students to at least paraphrase or perform some other transformation of the presented text; these activities entail "deeper processing" (see R. Anderson, 1972).

Outlining

Since outlining presumably requires deeper processing in order to produce an alternative representation of text meaning, it should theoretically be a relatively effective studying technique. Two early studies did find outlining after training to be superior to a reading-only strategy. In an extensive training program, Barton (1930) taught outlining to 96 high school students in three schools. The general processing strategy was: (a) skim the article to find the main subdivisions, (b) skim the article a second time to find the main subdivisions, and (c) read the article again carefully to find the facts corresponding to each subdivision. Students then applied the outlining strategy to two units of geography, ancient history, or American history materials. Performance on objective tests was significantly higher for students who had been trained in outlining than for matched groups who had similar instruction, except for the outlining training.

Salisbury (1935) administered a 30-lesson training program in outlining and summarizing to seventh, ninth, and twelfth grade English students. Compared with matched control subjects who received no training, the trained subjects

showed significant gains on a standardized reading test (equivalent to one or two grades of improvement) and on a standardized test of reasoning ability.

In contrast to the positive results of the Barton and Salisbury studies, four studies found outlining to be no more effective than other strategies, including repetitive reading (Arnold, 1942; Stordahl & Christensen, 1956; Todd & Kessler, 1971; Willmore, 1966). In none of these studies were students taught how to outline.

Two studies, therefore, suggest that with fairly extensive training in how to process information logically, students can learn to use outlining as an effective attention-focusing and processing device. It is not surprising that students need to be taught this complex skill in order to use it effectively. When students are told to outline but are given no training in how to do so, they may use the format of an outline but only process the text superficially. A potential problem with outlining as a studying aid is that it is very time-consuming to think through the logical relationships in text and represent the meaning in outline form.

Techniques for Representing Text Diagrammatically

Recently, three groups working independently have developed methods for visually representing the important relationships among ideas in text. These techniques make possible the transformation of linear prose into nonlinear symbolic representations that are presumably more closely matched to the way knowledge is stored in memory.

Two of the techniques, "Networking" and "Mapping," are conceptually very similar. Networking was developed at Texas Christian University and

expanded at the National Technical Institute for the Deaf in Rochester, New York. Mapping is the product of a development team at the Center for the Study of Reading, University of Illinois. Both Networking and Mapping are based on the assumption that there are a few fundamental relationships in text (including example, characteristic, definition, temporal, causal, compare/contrast) which are cued by standard lexical and syntactic devices. The third technique, "Schematizing," a product of the University of Amsterdam, allows for the representation of coordinate and subordinate relationships among ideas but does not distinguish the precise nature of the relationships.

Because these text representation techniques are so new, little research has been completed to test their effectiveness. However, studies by Dansereau (1979) with hearing college students and by Long, Hein, and Coggiola (Note 2) with deaf college students showed promising results for Networking. A study by Armbruster (1979) showed facilitative effects for Mapping as a reading comprehension/studying technique for middle school students.

The promise of methods like Networking, Mapping, and Schematizing as studying aids probably lies in the fact that they force the student to attend to and process the relationships among <u>all</u> idea units in order to translate the prose into a coherent diagram. The benefit of this intense processing must be weighed against the costs. As with outlining, these techniques need to be taught to students before they can be used effectively. Also, with any of these strategies, students must spend considerable time constructing a visual representation of text.

Conclusion about the Research on Common Studying Techniques

Using the notions of state and processing variables, particularly the theoretical perspectives of encoding specificity and levels of processing, we have attempted to impose some order on the otherwise confusing array of results of research on common studying techniques. We believe that the following conclusions are warranted. Almost any technique can be effective if its use is accompanied by focused attention and encoding in a form and manner appropriate to the criterion task. However, some techniques have more potential than others for promoting the deeper processing suited to criterion tasks requiring greater comprehension and/or recall. These techniques include outlining, Networking, Mapping, and Schematizing, which all force students to identify or impose relationships that convey the meaning of text. Not surprisingly, these techniques that are likely to yield the highest learning benefits also have the greatest costs in student time and energy.

Conclusions

This review leads us to some simple notions about the complex phenomenon of studying. First, regarding state variables, we see that when the criterion tasks associated with studying are made explicit, as compared to remaining vague, students spend more time and effort on the relevant segments of texts, and learning outcomes generally improve. Second, regarding processing variables, when students know the nature of the criterion task as well as the type of relevant encoding activities in which to engage, their performance on the criterion task improves.

There is some evidence that those studying techniques which encourage students to process virtually all of the ideas found in text at a deep level improve learning of main and less important points. Examples of these techniques are outlining, Mapping, and Networking. These techniques demand a trade-off, however, in that a lot of time and substantial amounts of effort are required to learn and employ them properly. Both of these commodities are at a premium for most students.

Consequently, we seem to be portraying a potential dilemma. On the one hand, we know that students will never have a list of clear criteria available at every studying session so as to make their efforts more efficient. On the other hand, the incentive is not high enough for students to devote the time and effort required for outlining and Networking/Mapping/Schematizing. As is common knowledge, however, the picture is not a true dilemma. For example, good students know when to employ deep processing strategies and when it would be a waste of time to do so. They also know whether they understand an idea or not, and what to do if comprehension has failed. In other words, there is a higher-order processor, metacognition, which students can and do use in the studying process. We have not devoted space to this notion because it is developed elsewhere (Pearson, in press).

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